# D E C L A R A T I O N

In the matter of U.S. Patent
Application Ser. No. 10/568,683
in the name of Sumi TANAKA, et al.

I, Mariko ENDO, of Kyowa Patent and Law Office, 2-3, Marunouchi 3-Chome, Chiyoda-Ku, Tokyo-To, Japan, declare and say:

that I am thoroughly conversant with both the Japanese and English languages; and,

that the attached document represents a true English translation of Japanese Patent Application No. 2003-294425 filed on August 18, 2003.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Dated: March 18, 2008

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2003-294425

Name of Document: Patent Application

Reference Number: JPP032259

Application Date: August 18, 2003

To: Yasuo IMAI, Commissioner of the Patent Office

International Patent Classification: H01L 21/02
H01L 21/68

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Indication of the Fee:
Deposit Account Number: 002989
Fee: 21,000 Yen

List of Documents filed:

| | |
|---|---|
| Claim | 1 |
| Specification | 1 |
| Drawing | 1 |
| Abstract | 1 |

[Claim 1]

A substrate holding structure comprising:

a support column; and

a substrate holding table formed on said support column, wherein:

said substrate holding table includes a heating mechanism;

said support column includes, at a joint with said substrate holding table, a flanged part having an inner circumferential surface and an outer circumferential surface;

said inner circumferential surface provides an inclined surface, which is inclined such that an inner diameter of said flanged part successively increases as approaching the lower surface of said substrate holding table;

said outer circumferential surface provides an inclined surface, which is inclined such that an outer diameter of said flanged part successively increases as approaching the lower surface of said substrate holding table; and

said inclined surface constituting said outer circumferential surface undergoes continuous transition to the lower surface of said substrate holding table.

[Claim 2]

The substrate holding structure according to claim 1, wherein the lower surface of said substrate holding table is formed in a flat surface at a part joined to said flanged part and an area surrounding the part.

[Claim 3]

A substrate holding structure comprising:

a support column; and

a substrate holding table formed on said support column, wherein:

said substrate holding table includes a heating mechanism;

said support column includes, at a joint with said substrate holding table, a flanged part having an inner circumferential surface and an outer circumferential surface;

said inner circumferential surface provides an inclined surface, which is inclined such that an inner diameter of said flanged part successively increases as

approaching the lower surface of said substrate holding table;

said substrate holding table is provided in a lower surface thereof with a U-shaped groove extending along an outer circumferential surface of said flanged part, and said U-shaped groove is formed of an inner circumferential surface and the outer circumferential surface; and

the inner circumferential surface of said U-shaped groove is integrally connected to the outer circumferential surface of said flanged parts.

[Claim 4]

The substrate holding structure according to any one of claims 1 to 3, wherein said heating mechanism includes an inner heating mechanism and an outer heating mechanism formed outside said inner heating mechanism, and said inner heating mechanism and outer heating mechanism are driven by first and second drive power supply systems both extending inside said support column, respectively.

[Claim 5]

The substrate holding structure according to claim 4, wherein said substrate holding table includes first and second semicircular conductive patterns, which are arranged below said heating mechanism and are connected to first and second power supply lines constituting said second drive power supply system, respectively, and said first and second conductive patterns substantially cover a front area of said substrate holding table except for gap areas defined between said first conductive pattern and second conductive pattern.

[Claim 6]

The substrate holding structure according to any one of claims 1 to 5, wherein said substrate holding table and said support column are made of ceramics.

[Claim 7]

A substrate processing apparatus comprising:

a processing vessel connected to an exhaust system;

a gas supply system that supplies a process gas into said processing vessel; and

the substrate holding structure, as defined in any one of claims 1 to 7, arranged in said processing vessel.

[Document Type] SPECIFICATION 2003-294425

[Title of Invention] SUBSTRATE HOLDING STRUCTURE AND SUBSTRATE PROCESSING APPARATUS

[Field of the Invention]

[0001]

The present invention relates to particularly a substrate holding structure used for holding a substrate to be processed in a substrate processing apparatus and a substrate processing apparatus utilizing the substrate holding structure, with regard to the production of semiconductor devices in general.

[Background Art]

[0002]

In a substrate processing apparatus, such as a CVD apparatus, a plasma-assisted CVD apparatus, a hest treating apparatus or an etching apparatus, a substrate holding structure is arranged in a processing vessel to hold a substrate to be processed. Such a substrate holding structure includes a substrate holding table for holding the substrate to be processed and a support column for supporting the said substrate holding table. A heating mechanism is arranged in the said substrate holding table to process the substrate in a predetermined manner by heating it at a predetermined temperature.

[0003]

In particular, in CVD apparatuses including plasma-assisted CVD apparatuses and heat treatment apparatuses, a substrate to be processed has to be heated at a temperature of 400°C or more, in some cases, 600°C or more. With such heating, a great temperature gradient is generated across the substrate holding table.

[0004]

The substrate holding table is generally made of a ceramic material, such as AlN, having excellent corrosion resistance. However, if thermal stress is induced into the substrate holding table due to the temperature gradient, the substrate holding table is possibly damaged.

[0005]

On the other hand, JP2002-373837A discloses a structure to have a curvature outside a joint between the substrate holding table and its support column and reduce stress concentration.

[0006]

Fig. 1 shows the overall structure of a substrate holding structure including a substrate holding table 10 shown in the above-mentioned JP2002-373837A, and Fig. 2 shows the vicinity of the said joint.

[0007]

Referring to Fig. 1, the substrate holding table 10 is held on the support column 11. The said support column 11 is provided with a flanged part 11A at the joint to the holding table 10. Referring to Fig. 2, the support column 11 is provided with a curved surface 11B at a transition part from a main part of the support column 11 to the said flanged part 11A to reduce thermal stress concentration at the transition part. Further, in the structure shown in Fig. 2, the joint to the said flanged part 11A on the bottom surface of the said substrate holding table 10 has a thick joint part 10A that is defined by a curved surface 10B whose profile undergoes continuous transition to the profile of the said flanged part 11A.

[0008]

According to the arrangement of Figs. 1 and 2, as substrate holding table 10 is formed thinner than the said thick joint part 10A, thereby reducing an amount of heat transferred in the said substrate holding table 10. In addition, as the sidewall surface of the said thick joint part 10A is formed of a curved surface that undergoes continuous transition to the sidewall surface of the said flanged part 11A, thermal stress concentration at the joint is prevented.

[Patent Document 1] JP2002-373837A

[Patent Document 2] JP2000-169268A

[Patent Document 3] JP2000-290773A

[Patent Document 4] JP2002-184844A

[Patent Document 5] JP5-101871A

[Patent Document 6] JP7-230876A

[Disclosure of the Invention]

[Problems to be solved by the Invention]

[0009]

However, in such a conventional substrate holding structure, it is necessary to grind the whole area of the back surface of the substrate holding table 10 other than the said thick joint part 10A. However, as the substrate holding table 10 is generally made of a ceramic material which is dense and difficult to grind large hardness, such as AlN, the grinding of such a large area greatly increases the manufacturing cost of a substrate processing apparatus.

[0010]

On the contrary, if the substrate holding table 10 is not ground in the above manner, thermal stress caused by a temperature gradient induced in the substrate holding table 10 is concentrated on the boundary between the said flanged part 11A and the substrate holding table 10, resulting in damage of the substrate holding table 10.

[Means to solve the Problems]

[0011]

Then, a comprehensive object of the present invention is to provide a novel and useful substrate holding structure and a substrate processing apparatus using such a substrate holding structure, in which the above-described problems are solved.

[0012]

More specifically, an object of the present invention is to provide a substrate holding structure, which can be made at a low manufacturing cost, reduce a generation of a temperature gradient and suppress thermal stress concentration, and also to provide a substrate processing apparatus employing such a substrate holding structure.

[0013]

The present invention achieves the above-mentioned objects,

as described in claim 1,

with a substrate holding structure comprising:

a support column; and

a substrate holding table formed on the said support column, wherein:

the said substrate holding table includes a heating mechanism;

the said support column includes, at a joint with the said substrate holding table, a flanged part having an inner circumferential surface and an outer circumferential surface;

the said inner circumferential surface provides an inclined surface, which is inclined such that an inner diameter of the said flanged part successively increases as approaching the lower surface of the said substrate holding table;

the said outer circumferential surface provides an inclined surface, which is inclined such that an outer diameter of the said flanged part successively increases as approaching the lower surface of the said substrate holding table; and

the said inclined surface constituting the said outer circumferential surface undergoes continuous transition to the lower surface of the said substrate holding table; or

as described in claim 2,

with the substrate holding structure according to claim 1, wherein the lower surface of the said substrate holding table is formed in a flat surface at a part joined to the said flanged part and an area surrounding the part, or

as described in claim 3,

with a substrate holding structure comprising:

a support column; and

a substrate holding table formed on the said support column, wherein:

the said substrate holding table includes a heating mechanism;

the said support column includes, at a joint with the said substrate holding table, a flanged part having an inner circumferential surface and an outer circumferential surface;

the said inner circumferential surface provides an inclined surface, which is inclined such that an inner diameter of the said flanged part successively increases as approaching the lower surface of the said substrate holding table;

the said substrate holding table is provided in a lower surface thereof with a

U-shaped groove extending along an outer circumferential surface of the said flanged part, and the said U-shaped groove is formed of an inner circumferential surface and the outer circumferential surface; and

the inner circumferential surface of the said U-shaped groove is integrally connected to the outer circumferential surface of the said flanged parts, or

as described in claim 4,

with the substrate holding structure according to any one of claims 1 to 3, wherein the said heating mechanism includes an inner heating mechanism and an outer heating mechanism formed outside the said inner heating mechanism, and the said inner heating mechanism and outer heating mechanism are driven by first and second drive power supply systems both extending inside the said support column, respectively, or

as described in claim 5,

with the substrate holding structure according to claim 4, wherein the said substrate holding table includes first and second semicircular conductive patterns, which are arranged below the said heating mechanism and are connected to first and second power supply lines constituting the said second drive power supply system, respectively, and the said first and second conductive patterns substantially cover a front area of the said substrate holding table except for gap areas defined between the said first conductive pattern and second conductive pattern, or

as described in claim 6,

with the substrate holding structure according to any one of claims 1 to 5, wherein the said substrate holding table and the said support column are made of ceramics, or

as described in claim 7,

with a substrate processing apparatus comprising:

a processing vessel connected to an exhaust system;

a gas supply system that supplies a process gas into the said processing vessel; and

the substrate holding structure, as defined in any one of claims 1 to 7,

arranged in the said processing vessel.

[Effects of the Invention]

[0014]

According to the characteristics described in claims 1 and 2 of the present invention, inclined surfaces are formed on inner and outer circumferential surfaces of the said flanged part, respectively, so that an inner diameter and outer diameter of the said flanged part successively increase to the lower surface of the said substrate holding table and, in this case, each of the said inclined surfaces constituting the said outer circumferential surface undergoes continuous transition to the lower surface of the said substrate holding table. Thus, it is possible to reduce concentration of thermal stress on the said support column and substrate holding table without the lower surface of the said substrate holding table being ground.

[0015]

According to the characteristics described in claim 3 of the present invention, an inclined surface is formed on an inner circumference of the said flanged part so that an inner diameter of the said flanged part successively increases to the lower surface of the said substrate holding table and, further, the said substrate holding table is provided in a lower surface thereof with a U-shaped groove extending along an outer circumferential surface of the said flanged part, and the inner circumferential surface of the said U-shaped groove is integrally connected to the said outer circumferential surface. Thus, it is possible to reduce concentration of thermal stress on the said support column and substrate holding table with minimum grinding processing on the lower surface of the said substrate holding table.

[0016]

According to the characteristics described in claim 4 of the present invention, a heating mechanism on the said substrate holding table includes an inner heating mechanism and an outer heating mechanism formed outside the said inner heating mechanism, and the said inner heating mechanism and outer heating mechanism are driven separately, so that it is possible to reduce a temperature gradient in the substrate holding table and, therefore, suppress the generation of thermal stress and

to process a substrate uniformly.

[0017]

According to the characteristics described in claim 5 of the present invention, the said substrate holding table includes first and second conductive patterns with gap areas defined therebetween, which are arranged below the said heating mechanism as a part of a driving system to drive the said outer heating mechanism. Thus, it is possible to make temperature distribution on the said substrate holding table more uniform with heat conduction through such conductive patterns.

[0018]

According to the characteristics described in claim 6 of the present invention, the said substrate holding table and support column are made of ceramics, which is excellent in corrosion resistance. Thus, it is possible to process a substrate in a predetermined manner in various atmospheres on the substrate holding table.

[0019]

According to the characteristics described in claim 7 of the present invention, it is possible to obtain an inexpensive substrate processing apparatus that can stably process a substrate with low maintenance frequency with such a substrate holding structure being arranged in the processing vessel.

[Best Mode for carrying out the Invention]

[0020]

[First Embodiment]

Fig. 3 shows the constitution of a substrate processing apparatus 20 in the first embodiment of the present invention, while Figs. 4 to 7 show the constitution of a substrate holding structure 50 employed in the substrate processing apparatus 20 of Fig. 3.

[0021]

Referring to Fig. 3, the substrate processing apparatus 20 includes a processing vessel 21 connected to an exhaust system (not shown) through an exhaust port 21A. A shower head 22 is arranged at the top of the said processing vessel 21 to discharge a process gas, which is supplied from an external gas source (not shown).

through a line L, into a processing space in the said processing vessel 21 through a number of openings 22A. A substrate holding table 23 for holding a substrate to be processed (not shown) is disposed in the said processing vessel 21 so as to oppose the said shower head 22.

[0022]

The said substrate holding table 23 is made of a ceramic material, such as AlN, having excellent corrosion resistance, high heat conductivity, high resistivity and excellent thermal-shock resistance, and is supported on a support column 23A also made of a ceramic material, such as AlN. The said support column extends through an extension part 21B extending downward from a bottom part of the said processing vessel 21, and is fixed to an end part 21C of the said extension part 21B. Power supply lines 23a and 23b extend through the said support column 23A for driving a heating mechanism (heater) embedded in the said substrate holding table 23. The said power supply lines 23a and 23b are drawn out through a terminal chamber 21D, which is provided at the said end part 21C for inhibiting oxidation or corrosion of the power supply lines. In addition, the said terminal chamber 21D is provided with an exhaust port 21d for exhausting the interior of the said support column 23A.

[0023]

Further, an opening 21E for loading and unloading of a substrate to be processed is formed in the said processing vessel 21D at a level corresponding to said the substrate holding table 23. The said substrate holding table 23 is provided with lifter pins, not shown, to lift up a substrate after being processed.

[0024]

The substrate holding table 23 of Fig. 3 is provided with a structure for reducing thermal stress, which will be described later. However, for simplicity of drawings, Figs. 3 and 4 to 6 do not illustrate that structure.

[0025]

Figs. 4 to 6 show the heating mechanism embedded in the said substrate holding table 23.

[0026]

Referring to Fig. 4, the said heating mechanism includes an inner heater pattern 24A formed in the vicinity of the center of the substrate holding table 23 and an outer heater pattern 24B formed outside the said inner heater pattern 24A. The said inner heater pattern 24A is supplied with electric power through the said power supply line 23a, and the said outer heater pattern 24B is supplied with electric power through the said power supply line 23b and a power supply pattern 24C formed below the said heater patterns 24A and 24B.

[0027]

Fig. 5 shows a planar arrangement of the said heater patterns 24A and 24B.

[0028]

Referring to Fig. 5, the said heater patterns 24A and 24B are formed in a film of a heat-resistant metal, such as W or Mo, which is uniformly formed on the substrate holding table 23 made of A1N or the like with cutouts 24c being patterned. The said heater pattern 24A is connected to one of power-supply wires of the said power supply line 23a at a connecting part 23a, and is connected to the other of the power-supply wires thereof at a connecting part 23a'. Further, the said heater pattern 24B is connected to a power-supply pattern $24C_1$ connected to one of the power-supply wires of the said power supply line 23b at a connecting part 23c, and is connected to a power-supply pattern $24C_2$ connected to the other of the power-supply wires thereof at a connecting part 23c'.

[0029]

Fig. 6 shows the said power supply patterns $24C_1$ and $24C_2$.

[0030]

Referring to Fig. 6, the power supply patterns $24C_1$ and $24C_2$ comprise semicircular conductive films and are formed with a film of a heat-resistant metal being patterned, such as W or Mo, which is uniformly formed on the said substrate holding table 23. The said power supply patterns $24C_1$ and $24C_2$ are, integrally shown as the power supply pattern 24C in Fig. 5. The power supply pattern $24C_1$ is, however connected to one of the power supply wires of the said power supply line 23b at a

connecting part 23d, while the power supply pattern $24C_2$ is connected to the other of the power-supply wires of the said power supply line 23b at a connecting part 23d'.

[0031]

In this way, with the substrate holding table 23 of this embodiment, as the inner heater pattern 24A and the outer heater pattern 24B are supplied with electric power independently, it is possible to minimize a temperature gradient generated in the said substrate holding table 23, reducing the possibility of damage, such as the generation of cracking, caused by the temperature gradient. In addition, as the temperature distribution of the inner area and outer area of the substrate holding table 23 can be controlled independently as such, uniformity in processing a substrate can be improved.

[0032]

Fig. 7 shows a structure for reducing thermal stress, which is employed in the substrate holding table 23 of Fig. 3.

[0033]

Referring to Fig. 7, the support column 23A for supporting the said substrate holding table 23 includes a flanged part 23B provided at the joint with the said substrate holding table 23. In this embodiment, however, formed in a lower surface of the said substrate holding table 23 is a U-shaped groove 23U corresponding to an outer circumferential surface $23B_1$ of the said flanged part 23B.

[0034]

The said U-shaped groove 23U is formed in a ring shape outside the said flanged part 23B and is defined by an inner circumferential surface $23U_1$ corresponding to the said outer circumferential surface $23B_1$ of the said flanged part 23B, an outer circumferential surface $23U_2$ corresponding to the said inner circumferential surface, and a bottom surface $23U_3$ connecting the said inner circumferential surface and the outer circumferential surface. Curved surfaces having a curvature radius $R_1$ are formed in a corner part between the said inner circumferential surface $23U_1$ and the bottom surface $23U_3$ and in a corner part between the said bottom surface $23U_3$ and the outer circumferential surface $23U_2$.

[0035]

Thus, the formation of the U-shaped groove 23U at the bottom surface of the said substrate holding table 23 along the outer circumferential surface $23B_1$ of the said flanged part 23B leads to the reduction in concentration of thermal stress induced along the outer circumferential surface $23B_1$ of the said flanged part 23B when the said substrate holding table 23 has a difference in temperature in a radius direction, and prevents damage, such as the generation of a crack.

[0036]

In the structure shown in Fig. 7, an inclined surface 23f is formed also in the inner circumferential surface of the said flanged part 23B. Thus, concentration of thermal stress is reduced on a joint between the said inclined surface 23f and the substrate holding table 23 compared with the conventional structures shown in Figs. 1 and 2. Further, in the structure shown in Fig. 7, a curved surface 23R having a curvature $R_2$ is also formed at a transitional part from the said support column 23A to the flanged part 23B, thereby reducing the concentration of thermal stress on this part.

[0037]

Fig. 8(A) shows stress distribution in the substrate holding structure of Fig. 7 when the said substrate holding structure 23 shows a so-called center-cool temperature gradient, where the temperature of the center part is low while the temperature of the peripheral part is high. However, a scale of a stress shown in the drawing is kgf · $mm^{-2}$. In the drawing, a positive value represents a tensile stress, while a negative value represents a compressive stress.

[0038]

Referring to Fig. 8(A), as the center part of the said substrate holding table 23 is contracted in comparison with the peripheral part under the center-cool condition, a tensile stress mainly tends to be induced therein, particularly, at a position thereof corresponding to the outer circumferential surface of the flanged part 23B. However, it is obvious that the stress concentration is remarkably reduced due to the provision of the U-shaped groove 23U at a position corresponding to the outer circumferential surface. In the state shown in Fig. 8(A), it is obvious that the maximum tensile stress appears

in the curved surface part $23U_1$.

[0039]

On the other hand, Fig. 8(B) shows stress distribution under a so-called center-hot condition, where the temperature of the center part of the said substrate holding table 23B is high while the temperature of the peripheral part is low.

[0040]

In this case, it is found that almost ms thermal stress concentration appears in the vicinity of the joint with the said support column 23A in the substrate holding table 23.

[0041]

As mentioned above, according to the substrate holding structure in this embodiment, it is possible to form the substrate holding table having the structure for reducing thermal stress easily and inexpensively with the formation of the U-shaped groove 23U in a limited area along the outer circumferential surface of the flanged part 23B of the support column 23A at the lower surface of the substrate holding table 23 by grinding, unlike the aforementioned conventional technologies shown in Figs. 1 and 2, in which the lower surface of the substrate holding table needs to be ground in a large area. In this case, as the said heaters 24A and 24B are driven independently in the present invention, the temperature gradient induced in the substrate holding table 23 can be minimized. Consequently, it is possible to manufacture a substrate holding structure, which is reliable and has no risk of failure, at a low cost.

[2nd. Embodiment]

Fig. 9 shows a constitution of a substrate holding structure 40 in the second embodiment of the present invention. However, in Fig. 9, component parts identical to those mentioned above are designated by the same reference signs, and a duplicate description thereof is omitted.

[0042]

Referring to Fig. 9, the substrate holding structure 40 according to the second embodiment has a structure similar to the said substrate holding structure 20.

However, an outer circumferential part $23B_1$ of the flanged part 23B of the said substrate holding structure 20 is replaced with an inclined surface $33B_1$ inclined such that the diameter of the outer circumferential surface $23B_1$ gradually increases as approaching the back side of the said substrate holding table 23.

[0043]

In this case, a curved surface is formed in the said inclined surface $33B_1$ in this embodiment so that the inclined surface $33B_1$ undergoes continuous transition to the lower surface of the said substrate holding table 23. Consequently, there exists no step which causes stress concentration at a part between the said outer circumferential surface $33B_1$ and the lower surface of the said substrate holding table 23.

[0044]

According to this embodiment, it is unnecessary to grind the lower surface of the said substrate holding table 23. Therefore, the manufacturing cost of the substrate holding structure can be further reduced.

[0045]

Also in this embodiment, by driving the inner heater 23A and the outer heater 23B on the said substrate holding table 23 independently of each other, it is possible to minimize the generation of the temperature gradient in the substrate holding table 23 and thus, the generation of thermal stress itself can be restrained. Then, it becomes possible to form the substrate holding structure, which is inexpensive and highly reliable and has a long life, by combining with the formation of the said outer circumferential surface $33B_1$.

[0046]

In the above description, in addition the substrate holding structure 20 or 40 is used in the CVD apparatus of Fig. 3, but the invention is not limited to thereto and the same structure is generally applicable to various substrate processing apparatuses, such as a plasma-assisted CVD apparatus, a heat treatment (RTP) apparatus and an etching apparatus.

[0047]

The description has been made as above for preferred embodiments of the

present invention. However, the invention is not limited to the above-mentioned embodiments, and various changes and modifications are possible within the scope of claims.

[Brief Description of the Drawings]

[0048]

[Fig. 1]

A view showing the constitution of a conventional substrate holding structure.

[Fig. 2]

An enlarged view showing a part of the substrate holding structure of Fig. 1.

[Fig. 3]

A view showing the constitution of a substrate processing apparatus according to a first embodiment of the present invention.

[Fig. 4]

A view schematically showing the constitution of a substrate holding structure employed in the substrate processing apparatus of Fig. 3.

[Fig. 5]

A view showing a heater mechanism employed in the substrate holding structure of Fig. 4.

[Fig. 6]

Another view showing the heating mechanism employed in the substrate holding structure of Fig. 4.

[Fig. 7]

A view showing the stress concentration-reducing constitution employed in the substrate holding structure of Fig. 4.

[Fig. 8]

(A) and (B) are charts showing distribution of thermal stress induced in the substrate holding structure of Fig. 7 under a center-cool condition and a center hot condition, respectively.

[Fig. 9]

A view showing the constitution of a substrate processing apparatus in a

second embodiment of the present invention.

[Descriptions of Numerical Symbols]

[0049]

| | |
|---|---|
| 10 | Substrate holding table |
| 10A | Projecting part |
| 10B | Sidewall surface |
| 11 | Support column |
| 11A | Flanged part |
| 11B | Transition part |
| 20 | Substrate processing apparatus |
| 21 | Processing vessel |
| 21A, 21d | Exhaust port |
| 21B | Extension part |
| 21C | End part |
| 21D | Terminal chamber |
| 21E | Opening |
| 22 | Shower head |
| 22A | Opening |
| 23 | Substrate holding table |
| 23A | Support column |
| 23B | Flanged part |
| $23B_1$ | Outer circumferential surface |
| 23R | Transitional part |
| 23U | U-shaped groove |
| $23U_1$ | Inner circumferential surface of U-shaped groove |
| $23U_2$ | Outer circumferential surface of U-shaped groove |
| $23U_3$ | Bottom surface of U-shaped groove |
| 23a, 23b | Power supply line |
| 23a, 23a', 23c, 23c', 23d, 23d' | Connecting part |

| | |
|---|---|
| 23f | Inner circumferential surface of flanged part |
| 24 | Heating mechanism |
| 24A | Inner heater pattern |
| 24B | Outer heater pattern |
| 24C, $24C_1$, $24C_2$ | Power supply pattern |

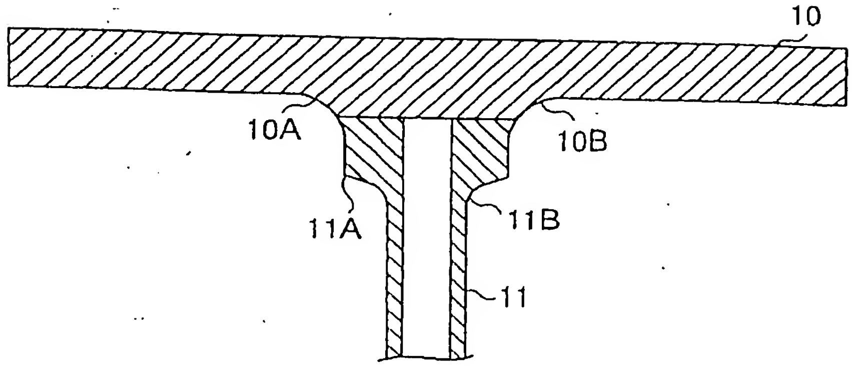


Fig. 1

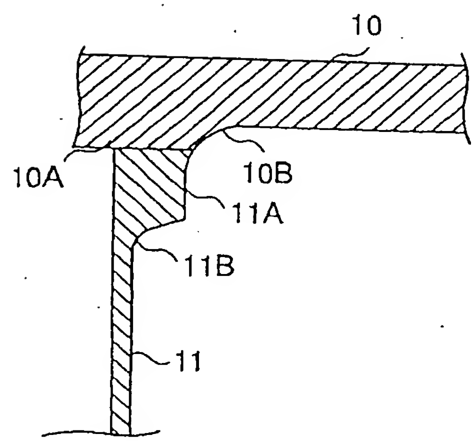


Fig. 2

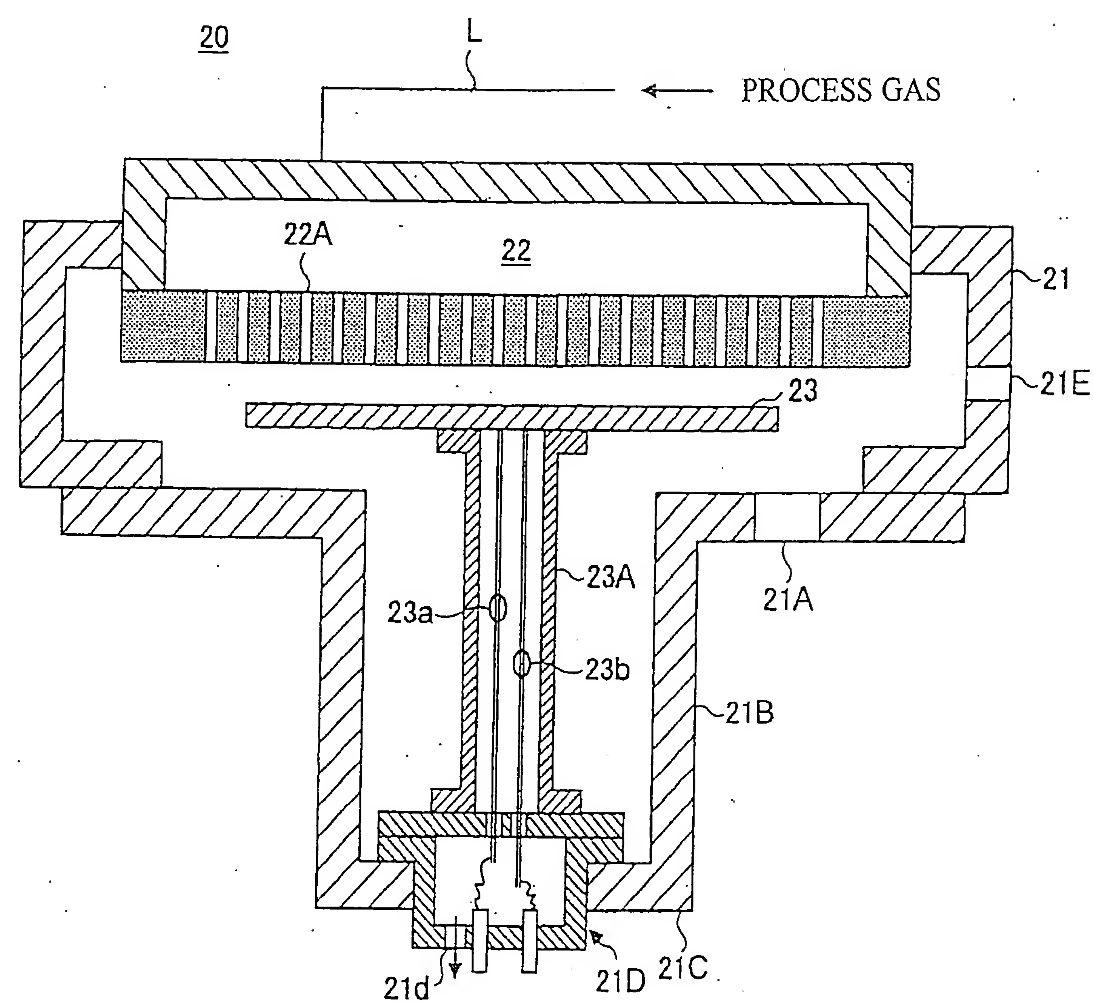


Fig. 3

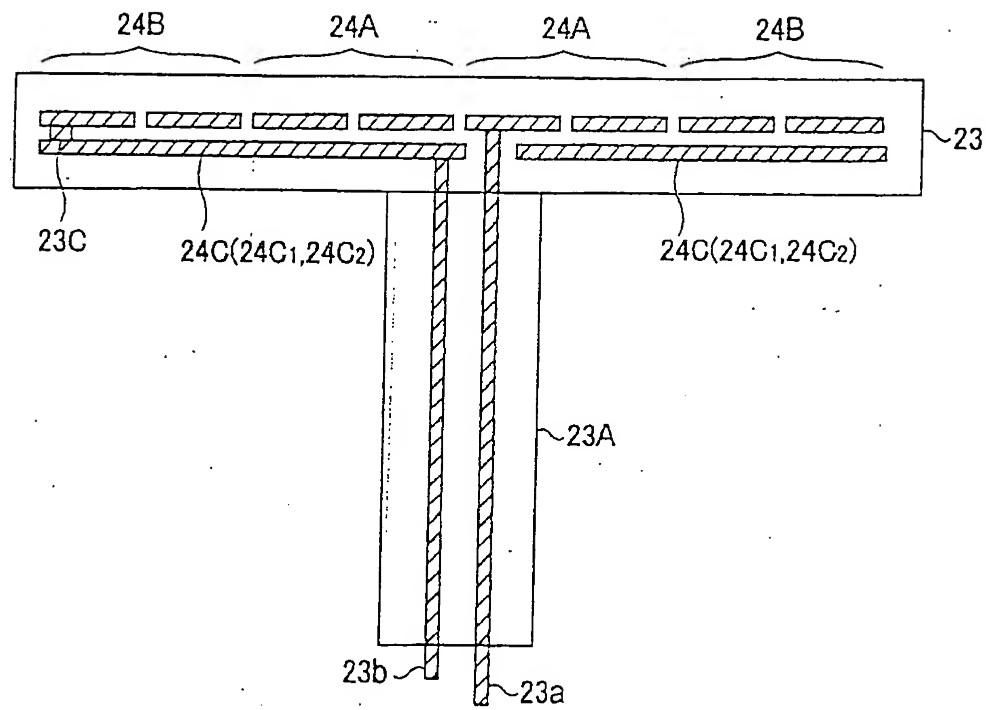


Fig. 4

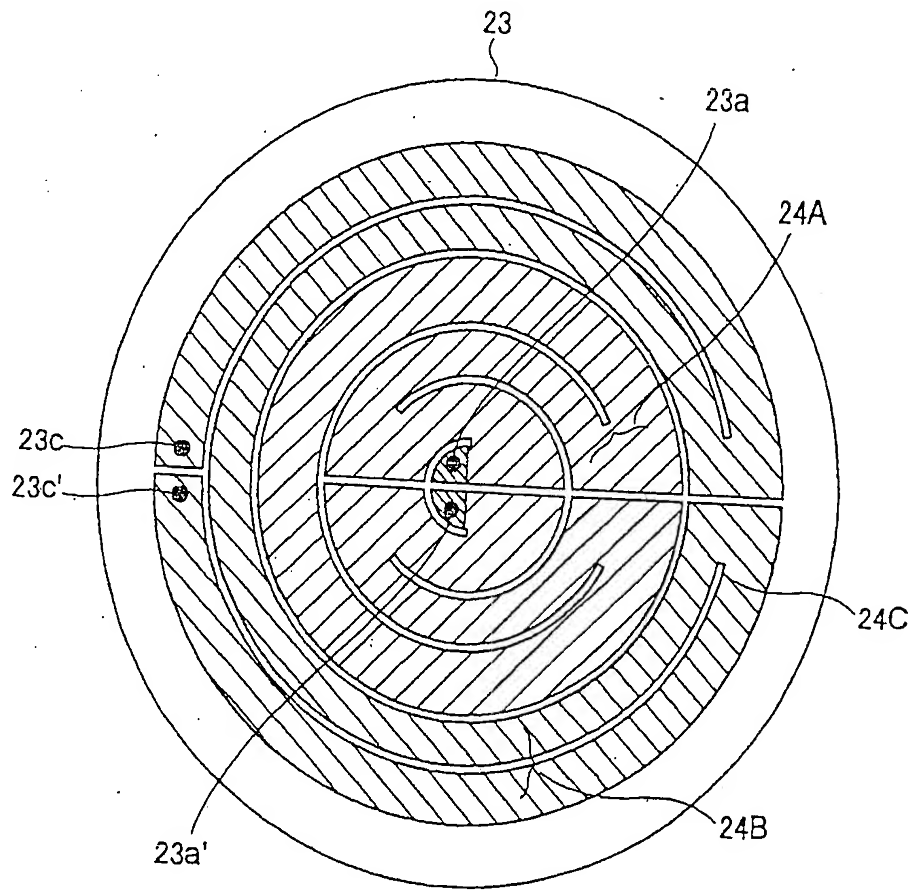


Fig. 5

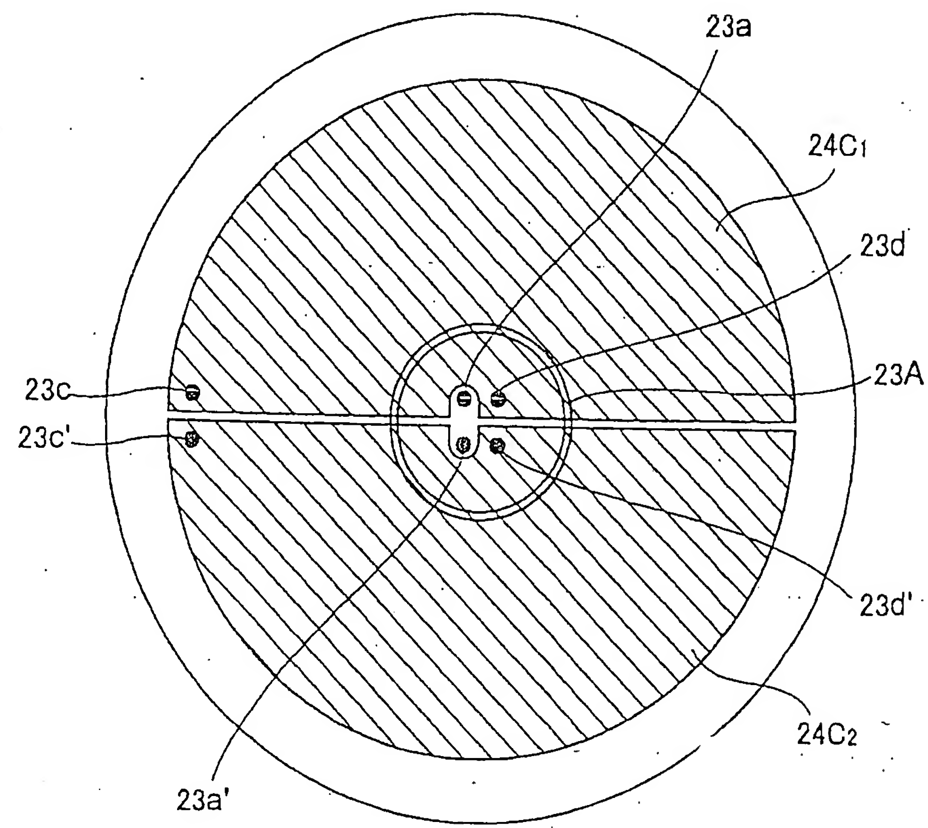


Fig. 6

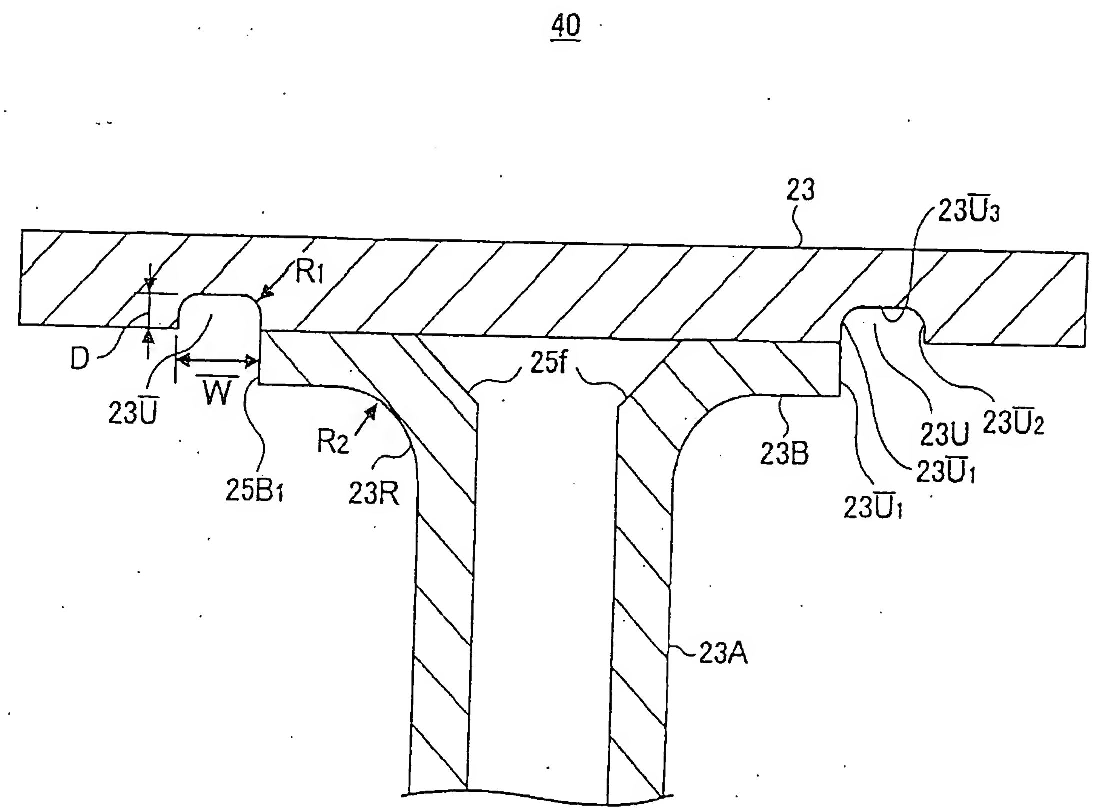
40
23
$23\overline{U}_3$
$R_1$
D
$23\overline{U}$
W
25f
$R_2$
$25B_1$
23R
23B
23U
$23\overline{U}_2$
$23\overline{U}_1$
$23\overline{U}_1$
23A

Fig. 7

(A)

(B)

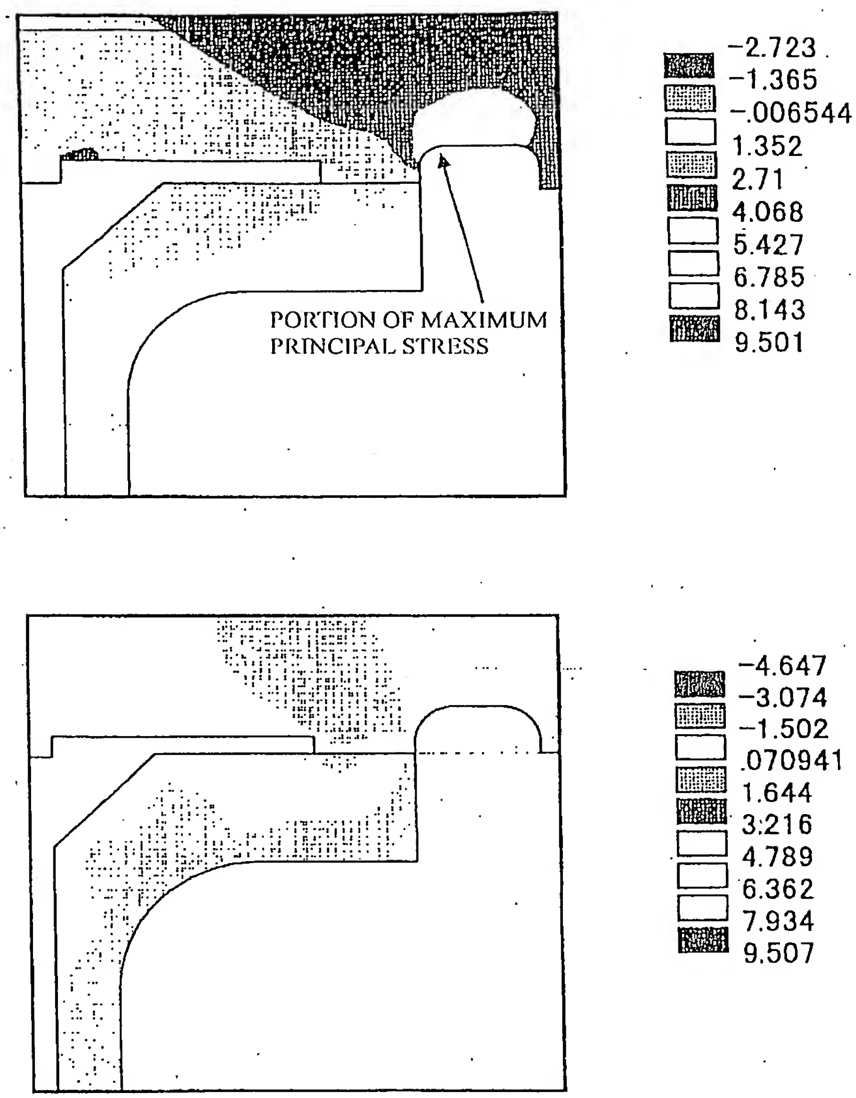
-2.723
-1.365
-.006544
1.352
2.71
4.068
5.427
6.785
8.143
9.501
PORTION OF MAXIMUM PRINCIPAL STRESS
-4.647
-3.074
-1.502
.070941
1.644
3:216
4.789
6.362
7.934
9.507

Fig. 8

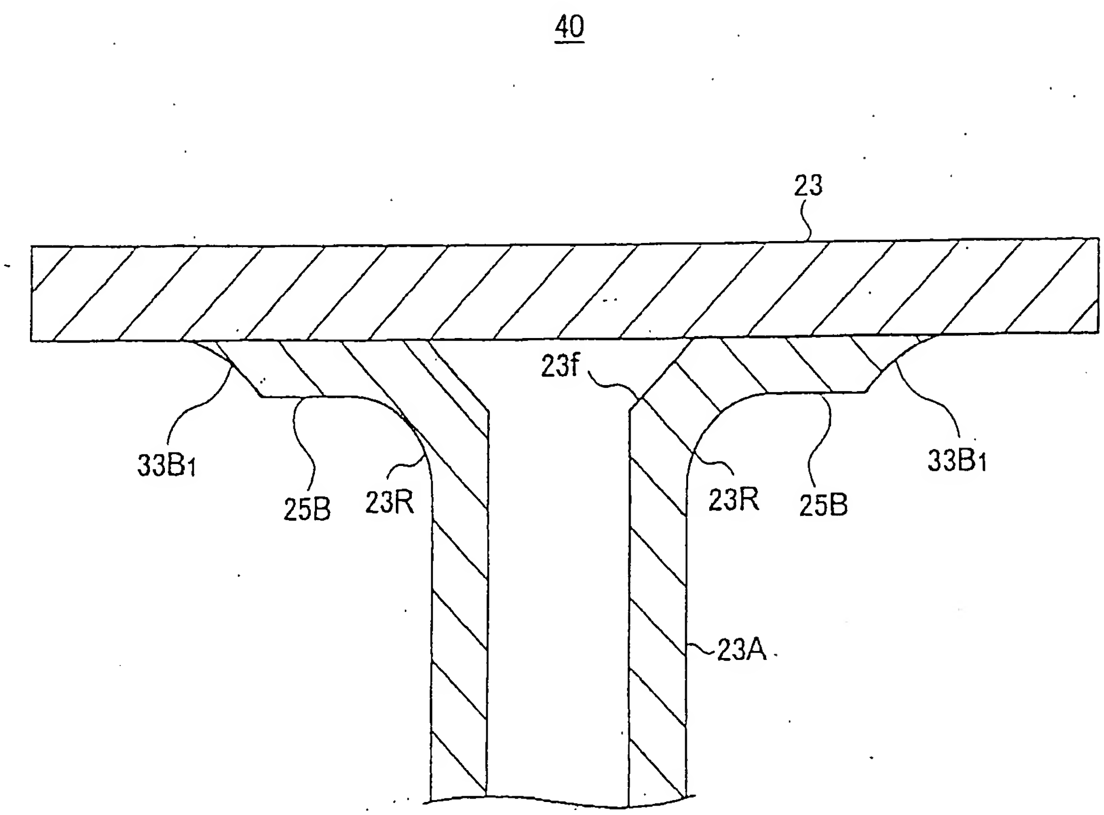


Fig. 9

[Document Type] ABSTRACT OF THE DISCLOSURE

[Abstract]

[Object]

To prevent damage due to thermal stress induced into a substrate holding table in a substrate holding structure for holding a substrate to be processed.

[Means for Solving the Problems]

In the substrate holding structure having the substrate holding table arranged at the top of a support column, a flanged part is defined by an inner circumferential surface and an outer circumferential surface at a joint between the said support column and the said substrate holding table. Then, the said inner circumferential surface is formed of an inclined surface, which is inclined such that the inner diameter of the said flanged part successively increases as approaching the lower surface of the said substrate holding table. Further, on the lower surface of the said substrate holding table to which the said flanged part is joined, a U-shaped groove is formed so as to correspond to the outer circumferential surface of the said flanged part.

[Selected Figure]

Fig. 7